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Description

[0001] The present application relates to an inhaler for delivery of medicament from a canister, particularly to an actuation mechanism for actuating a canister held in the inhaler.

[0002] Inhalers are commonly used to deliver a wide range of medicaments. The inhaler holds a canister of medicament which is actuatable, for example by compression, to deliver a dose of medicament. Some known inhalers are provided with an actuation mechanism for actuating the canister. The mechanism may be breath-actuated ie. arranged to actuate the canister in response to inhalation at the mouth piece. Typically a breath-actuated inhaler includes a loading mechanism for loading a resilient loading element with an actuation force for compression of the canister. A triggering mechanism may be provided to hold the resilient loading element against compression of the canister, the triggering mechanism releasing the resilient loading element upon inhalation. Such a breath-actuated inhaler is described in for example WO 9949916.

[0003] Important considerations for an actuation mechanism are reliability and simplicity. Reliability is important to ensure that the medicament is correctly delivered on every use, especially when the medicament is required by the user in an emergency. A simple structure is required firstly to assist in ensuring that the actuation mechanism operates reliably and secondly to simplify manufacture, thereby reducing manufacturing costs.

[0004] A problem often encountered, especially by elderly, young and infirm users, is that it is difficult to generate enough force to load the resilient loading element provided to bias actuation of the canister. The energy with which the resilient loading element is loaded must be sufficient to actuate the canister which can create difficulties for some users. The first aspect of the present invention is intended to assist in loading of the mechanism.

[0005] According to the first aspect of the present invention, there is provided an inhaler for delivery by inhalation of a medicament from a canister which is compressible to deliver a dose of medicament, the inhaler comprising a housing for holding a canister having a generally cylindrical body with the cylindrical axis of the body in predetermined direction;

a loading mechanism for loading a resilient loading element which is arranged, when loaded, to bias compression of the canister, the loading mechanism comprising:

- a loading member engaging the resilient loading element; and
- at least one contact member movable relative to the housing in a movement direction orthogonal to said predetermined direction and arranged to drive the loading member to load the resilient loading element through a cam arrangement between the at least one contact member and the loading member.

[0006] By arranging the contact member(s) to be movable relative to the housing in a movement direction orthogonal to the cylindrical axis of the body of the canister held in the housing, loading is made easier. The inhaler may be held in the palm of one hand with the body of the canister aligned generally upwardly. Sideways movement of the contact member(s) may then be easily achieved by gripping the inhaler between a finger and thumb. A cam arrangement is particularly advantageous for driving the loading member to load the resilient loading element through a cam arrangement between the contact member(s) and the loading member. It meets the requirements for both reliability and simplicity. Furthermore it allows the loading member to be suitably arranged in the inhaler when the contact member(s) have the convenient arrangement of being movable orthogonal to the predetermined direction of the axis of the canister.

[0007] In particular, the cam arrangement allows the movement of the contact member(s) to be converted into movement of the loading member in a direction orthogonal to said movement direction, ie. in a plane parallel to the predetermined direction in which the cylindrical axis of the body of the canister is held. As a result, the resilient loading element may be simply configured to bias compression of the canister.

[0008] Desirably the loading member is driven to rotate in said direction orthogonal to said movement direction. This is advantageous because it converts the linear force provided to the contact member(s) into a rotational movement. This assists in loading of the resilient loading element and provides a simpler and more reliable mechanism than if the loading element was movable linearly, say along a track.

[0009] The resilient loading element may be a torsion spring. It may bias a canister engagement member engageable with a canister held in the housing to compress the canister which may be a lever rotatable about an axis parallel to the movement direction of the at least one contact member. Thus, a simple configuration with a reliable action is provided.

[0010] Preferably, the inhaler has two contact members disposed on opposite sides of the housing. This improves the ease of operation. The two contact members may be depressed together between a finger and a thumb with the inhaler held in the palm of a hand. An alternative would be to provide a single contact member which the user may push relative to the housing.

[0011] As a result of the gearing ratio of the amount of driven movement of the loading member to the amount of movement of the contact member(s) being a non-linear function of the position of the loading member, it is possible to control the amount of force which the user needs to apply over the movement stroke of the contact member(s) relative to the housing. This technique can be used to produce a number of technical advantages.

[0012] Preferably, said ratio reduces during at least a major portion of the driven movement of the loading member. This allows compensation for the reactive force generated by the resilient biassing element which must be overcome by the user. Generally, this reactive force increases as the resilient loading element is loaded. However compensation is provided by ensuring that the gearing ratio reduces during the driven movement of the loading member which in itself reduces the amount of force required by the user.

[0013] Desirably, the ratio varies such that the necessary force applied to the at least one contact member is substantially constant. If the loading force of the resilient biassing element increases linearly (by an amount which is for example proportional to the spring constant if the resilient loading element is a spring), then a linear resistance may be achieved if the ratio is inversely proportional to the position of the loading member during said major portion of its driven movement.

[0014] Secondly, varying the ratio non-linearly with the position of the loading member can provide the inhaler with a particular feel to the user operating the contact members. For example, it is desirable that wherein said ratio is reduced during an initial portion of the driven movement of the loading member relative to the a subsequent portion. In this way, the user initially feels a relatively low resistance to movement of the contact members. This not only increases the quality of the inhaler as perceived by the user, but also assists in application of force.

[0015] The invention may be implemented by means of the contact member(s) driving the loading member through a non-linear cam arrangement.

[0016] The invention is particularly suitable for use in an inhaler arranged to hold the resilient loading element against actuation of the canister and triggerable to release the resilient loading element or a breath-actuated inhaler in which the triggering mechanism is arranged to be triggered by inhalation.

[0017] To allow better understanding, an inhaler which embodies the present invention will now be described by way of non-limitative example with reference to the accompanying drawings, in which:

- Fig. 1 is a side view of the inhaler;
- Fig. 2 is a cross-sectional view of the inhaler illustrating the housing and duct;
- Fig. 3 is a side view of the duct;
- Fig. 4 is a side view of the canister and duct assembled together;
- Fig. 5 is an exploded view of the canister, collar and duct;
- Fig. 6 is a cross-sectional view of the canister and duct assembled together;
- Fig. 7is a view from the side and rear of the actuation mechanism;
- Fig. 8 is a view from the rear of the spindle;
- Fig. 9 is a view from the side, rear and above showing the arrangement of the resilient loading element;
- Fig. 10 is a schematic view of the cam surfaces formed on the spindle;
- Fig. 11 is a view from the side and rear of the triggering mechanism;
- Fig. 12 is a side view of the triggering mechanism;
- Fig. 13 is a side view of the locking mechanism;
- Fig. 14A to 14F are graphs showing the angular positions of the elements of the actuation mechanism during its operation sequence; and
- Figs. 15 to 22 are views of the actuation mechanism in various states during its operation sequence with views from opposite sides being suffixed by the letters A, B respectively.

[0018] As illustrated in Fig. 1, the inhaler has a housing 1 comprising an upper portion 19 and a lower portion 20. As illustrated in the cross-sectional view of Fig. 2, the upper housing portion 19 is a hollow shell which holds a canister 2 of medicament having a generally cylindrical body 3 held with its axis in a predetermined direction, vertical in Fig. 2. The upper housing portion 19 houses an actuation mechanism for actuating the canister 2 which will be described in more detail below.

[0019] The interior of the upper housing portion 19 is open to the atmosphere by means of air inlets 51 formed in the upper wall 52 of the upper housing portion 19. The location of the air inlets 51 minimises occlusion by the users hand which will normally grip the sides of the housing 1 and not cover the upper wall 52.

[0020] The canister 2 is compressible to deliver a dose of medicament. In particular the canister 2 has a valve stem 4 which is compressible relative to the body 3 to deliver a dose of medicament from the valve stem 4. The canister is of a known type including a metering chamber which captures a defined volume the medicament from the body 3 of the canister 2. This volume of medicament is delivered as a metered dose from the valve stem 4 on compression of the valve stem 4 relative to the body 3. The valve stem 4 is weakly biassed outwardly by an internal valve spring (not shown) to reset the canister 2 after compression for refilling the metering chamber.

[0021] The lower housing portion 20 is a hollow shell connected to the upper housing portion 19 by a sliding joint (not shown) which allows the lower portion 20 to be separated in the direction of the arrow in Fig. 1 by the user gripping textured surfaces 21 formed on the upper and lower housing portions 19 and 20. A cap 22 is hinged to the lower housing portion 20 by a flexible joint 23 to cover and uncover a mouthpiece 5 protruding from the lower housing portion 20.

[0022] As shown in Fig. 2, the lower housing portion 20 houses a duct 24 which is integrally formed with the mouthpiece 5, as illustrated in isolation in Fig. 3.

[0023] The duct 24 is assembled with a canister 2 as shown in Figs. 4 to 6. The duct 24 receives a nozzle block 11 in an opening 25. The valve stem 4 of the canister is received in the nozzle block 11 which is arranged to direct a dose of medicament delivered from the valve stem 4 out of the inhaler through the mouthpiece 5. The duct 24 and nozzle block 11 are separately formed. This allows each to be manufactured and subsequently assembled. This produces manufacturing and logistical savings because it facilitates different nozzle block designs being incorporated with a single duct design and vice versa.

[0024] A collar 26 is permanently connected to the canister 2. The collar 26 includes an annular retaining ring 27 permanently fitted around a necked portion 28 of the canister body 3. The retaining portion 27 prevents removal of the collar 26 from the canister such that the collar 26 is removed and replaced together with the canister 2. However, the retaining portion 27 and the canister 2 have a small degree of relative movement along the axis of the canister 5 to allow compression of the canister body 2 towards the valve stem 4.

[0025] The collar 26 further includes a front panel 29 integrally formed with the retaining ring 27. When the canister 2 is inserted in the housing 1, the front panel 29 of the collar 26 closes an opening formed between the upper housing portion 19 and the lower portion 20 and therefore forms a part of the outer wall of the housing 1. Accordingly, the presence or absence of the front panel 29 provides a visual indication to the user of whether or not a canister 2 has been inserted in the canister, because the collar 26 is permanently connected to the canister 2.

[0026] A pair of catch arms 30 integrally formed with the front panel 29 of the sides of the collar 26 catch the interior surface of the upper housing portion 19 to hold the collar 26 and the canister 2 in the upper housing portion 19.

[0027] The lower housing portion 20 has a stud 50 which locates the end of the nozzle block 11 as shown in Fig. 2 to hold the lower housing portion 20 and the duct 24 in place relative to one another. However, the lower housing portion 20 is not retained on the duct 24, so may be removed from the upper housing portion 19 leaving the canister 2 inserted in the upper housing portion 19 and the duct 24 held on the canister 2 by the valve stem 4 being inserted in the nozzle block 11. The duct 24 and nozzle block 11 may subsequently be slid off the valve stem 4 for cleaning or replacement. The canister 2 and collar 26 may be slid out from the upper housing portion 19 after depression of the catch arms 30. Subsequently a replacement canister 2 and collar 26 may be inserted.

[0028] Typically a new duct 24 and nozzle block 11 will be provided to the user with each new canister 2 so that the duct 24 and mouthpiece 5 are regularly replaced to prevent damage or dirt building up over time. The duct 24 has an opening 31 at its end opposite from the mouthpiece 5.

[0029] As shown in Fig. 2, the upper housing portion 19 holds a flap duct 32 which extends from a flow inlet 33 to a flap 13 which forms part of the triggering mechanism for the actuation mechanism as described in detail below. Therefore the duct 24 housed in the lower housing portion 19 and the flap duct 32 together define a composite duct shaped to direct the inhalation flow from the mouthpiece 5 to the flap 13. The composite duct formed by the duct 24 and the flap duct 32 is shaped to control the flow to the flap 13 to provide appropriate flow characteristics for proper operation of the flap 13.

[0030] The inhaler is further provided with an actuation mechanism 6. To assist understanding, a general description of the overall structure and operation of the actuation mechanism 6 will first be given.

[0031] An actuation force for compressing the canister 2 is stored in a resilient loading element in the form of a torsion spring 7. To load the torsion spring 7, the actuation mechanism 6 includes a loading mechanism consisting of a loading member in the form of a rotatable spindle 8 and two contact members in the form of buttons 9 which protrude from the housing as shown in Fig. 1. Depression of the buttons 9 towards one another, relative to the housing 1, drives the loading member 8 to load the torsion spring 7 through a cam arrangement between the buttons 9 and spindle 8.

[0032] The torsion spring 7 biasses compression of the canister 2 by engaging a canister engagement member in the form of a lever 10 which depresses the body 3 of the canister towards the stem 4 held in the nozzle block 11.

[0033] To allow storage of the actuation force in the torsion spring 7 after loading, the actuation mechanism 6 includes a triggering mechanism. This includes a locking lever 12 which holds the canister engagement lever 10 against compression of the canister 2. To release the canister engagement lever 10, the triggering mechanism further includes a vane in the form of a flap 13 which in a rest state holds the locking lever 12 in place. Inhalation at the mouthpiece 5 moves the flap 13 to release the locking member 12. This in turn releases the canister engagement lever 10 allowing the torsion spring 7 to drive compression of the canister 2.

[0034] The actuation mechanism 6 further includes a locking mechanism which locks the spindle 8 after loading of the torsion spring 7, thereby holding the torsion spring 7 in its loaded state before triggering and locking the canister in its compressed state after triggering.

[0035] The locking mechanism includes a catch 14 which, in a locking position, catches the spindle 8 and holds the torsion spring 7 in its loaded state. The locking mechanism further includes an intermediate member 15. A resilient biassing element in the form of a spring 16 is provided between the catch 14 and the intermediate member 15 to bias the catch 14 towards its locking position. The spring 16 allows deflection of the catch 14 by the spindle 8 during loading of the torsion spring 7.

[0036] Prior to inhalation the intermediate member 15 is held in place by the canister engagement lever 10. Upon inhalation at the mouthpiece 5, the flap 13 engages the intermediate member 15 to hold it in place. After compression by the canister engagement lever 10, the canister 2 is locked in its compressed state by the catch 14 of the locking mechanism holding the spindle 8 in place.

[0037] When the level of inhalation at the mouthpiece falls below a predetermined threshold, the flap 13 releases the intermediate member 15 to unload the biassing element 16 which in turn allows the catch 14 to release the spindle 8. After release by the catch 14, the spindle 8, torsion spring 7 and canister engagement lever 10 move upwardly and the canister resets.

[0038] Now there will be given a detailed description of the actuation mechanism 6, the entirety of which is illustrated in Fig. 7 and parts of which are illustrated in Figs. 8 to 13.

[0039] The loading mechanism is illustrated in Fig. 8 and consists of a rotatable spindle 8 and two contact members in the form of buttons 9 at both ends. The spindle 8 is rotatably mounted in the upper housing portion 19 about an axis orthogonal to the axis of the cylindrical body 3 of the canister 2. The spindle 8 has a pair of cam surfaces 8a disposed on opposite sides of the rotational axis of the spindle 8. The buttons 9 are mounted in the housing to be movable in a movement direction parallel to the rotational axis of the spindle 8. The buttons 9 each have a pair of inwardly projecting cam followers 9a which each engage a respective cam surface 8a of the spindle 8. The cam arrangement of the cam surfaces 8a and the cam followers 9a between the spindle 8 and the buttons 9 causes depression of the buttons 9 to drive rotation of the spindle 8.

[0040] As illustrated in Fig. 9, the torsion spring 7 which forms the resilient loading element is disposed with its coils 7a encircling a central cylindrical surface 8b of the spindle 8. A catch arm 8c protrudes radially from the spindle 8. A first leg 7b of the torsion spring 7 is restrained by the catch arm 8c so that the movement of the spindle 8 driven by the buttons 9 loads the torsion spring 7.

[0041] As illustrated schematically in Fig 10, the cam surfaces 8a have a non-linear shape which causes the gearing ratio of the amount of driven movement of the spindle 8 to the amount of movement of the buttons 9 to be a non-linear function of the rotational position of the spindle 8. The major portion 8b of each cam surface 8a is shaped with increasing pitch to compensate for the increased reactive loading force applied by the torsion spring 7 to the spindle 8 as the buttons 9 are depressed. In particular, they are shaped such that the necessary force applied to the buttons is substantially constant so the user feels a linear resistance. As the torsion spring 7 has a linear spring constant, this is achieved by shaping the major portion 8b of each cam surface 8a such that the gearing ratio is inversely proportion to the rotational position of the spindle 8.

[0042] Optionally, the outermost portion of the cam surfaces 8a which are contacted by the cam followers 9a during the initial portion of the driven movement of the spindle may have a decreased pitch, for example as illustrated by the dotted lines 8e. This is to reduce the gearing ratio relative to the subsequent major portion 8b. In this way the user initially feels a low resistance to movement of the buttons 9. This improves the feel perceived by the user and also assists the user in applying force.

[0043] Another option is to provide the final portion of the cam surface 8a with a detent, for example as illustrated by the dotted lines 8d. When the end of the cam followers 9a reach the detent 8d, the cam surface 8a of the spindle 8 no longer exerts a force urging the buttons outwardly on the buttons 9. At this position the detent 8d is urged by the torsion spring 7 against the side of the cam followers 9a and therefore holds the buttons 9 in their innermost position. This prevents the buttons 9 from loosely sliding back and forth after the torsion spring 7 has been loaded.

[0044] As shown in Fig. 9, the torsion spring 7 engages a canister engagement lever 10 which is pivotally mounted to the interior of the housing about an axis 10a. The canister engagement lever 10 is generally U-shaped with two parallel sides 10b connected by a cross piece 10c. A bar 10d extending between the two sides 10b bears on the body 5 of the canister 2. A mount 10e formed on the cross-piece 10c is engaged by the second leg 7c of the torsion spring 7, whereby loading of the torsion spring 7 biasses the lever 10 to compress the canister 2. The canister engagement lever 10 is biassed upwardly by a reset spring (not shown), which may be arranged as a torsion spring on the axis 10a, but this is weaker than the torsion spring 7.

[0045] The torsion spring 7, spindle 8 and canister engagement lever 10 are all rotatable about axis orthogonal to the cylindrical axis of the body 5 of the canister 2. This provides a simple and reliable loading mechanism particularly because of the arrangement of the torsion spring 7 with its coils 7a encircling the spindle 8. Some or all of these elements could alternatively be linearly movable in a plane parallel to the cylindrical axis of the body 5 of the canister 2 to achieve a loading mechanism which is equally simple to construct. However rotatable elements are preferred from the point of view of reliability in repeated use of the actuation mechanism 6.

[0046] On the other hand, the movement of the buttons in a direction orthogonal to the cylinder axis of the body 3 of the canister 2 assists the user in application of force to the loading mechanism. As typical for inhalers, the housing 1 extends in the direction of the cylindrical axis of the body 3 of the canister 2, so may be easily held in the palm of a hand with the buttons 9 protruding from either side. Thus the buttons 9 are easily depressed between a finger and thumb. Alternatively a single button could be provided allowing loading in a

similar manner by the user pressing the button and the housing on the opposite side to the button. Either configuration also allows loading by laying the inhaler on a surface and applying force for example with the palm of a hand. This facilitates loading by a user with limited finger control or movement, for example a chronic arthritis sufferer.

[0047] The actuation member mechanism 6 includes a triggering mechanism as illustrated in Figs. 11 and 12 which allows storage of the actuation force in the torsion spring 7 after loading.

[0048] The triggering mechanism includes a locking lever 12 which is pivotably mounted on an axle 17 extending across the interior of the housing 1. The locking lever 12 has a notch 12a adjacent the axle 17. In a reset state shown in Fig. 12, the notch 12a holds a protrusion 10f protruding from the cross-piece 10c of the canister engagement lever 10, thereby holding the lever 10 against compression of the canister 2. The locking lever 12 is weakly biassed towards the position shown in Figs. 11 and 12 by a reset spring 34 arranged as a torsion spring on the axle 17.

[0049] The triggering mechanism further includes a vane in the form of a flap 13 which is rotatably mounted on an axle 18 extending across the interior of the housing 1. The flap 13 biassed by a reset spring (not shown), which may be arranged as a torsion spring on the axle 18, towards the position shown in Fig. 12. The flap 13 has a locking lever engagement surface 13a which protrudes from a block 13b positioned above the axle 18. In the position shown in Fig. 12, the engagement surface 13a engages a contact surface 12b formed on the end of the locking lever 12 distal from the axle 17 to hold the locking lever 12 in place holding the canister engagement lever 10.

[0050] The flap 13 is disposed in the composite duct formed by the duct 24 and the flap duct 32 extending from the mouthpiece 5 with a flap portion 13c extending across the composite duct at the opposite end from the mouthpiece 5, where the duct opens into the interior of the housing 1. Therefore, the flap 13 is responsive to inhalation at the mouthpiece 5.

[0051] Inhalation of the mouthpiece draws the flap portion 13c into the flap duct 32 (clockwise in Fig. 2 and anticlockwise in Fig. 12). Such rotation of the flap 13 allows the locking lever engagement surface 13a to move out of contact with the contact surface 12b of the locking lever 12.

[0052] The upper housing portion 19 also mounts a button 35 disposed adjacent the flap 13 above the axle 18 so that depression of the button 35 rotates the flap 13 in the same direction as inhalation at the mouthpiece 5. Therefore, the button 35 allows the actuation mechanism 6 to be manually released without inhalation at the mouthpiece 5, for example to allow actuation of the canister 2 for testing.

[0053] When the canister engagement lever 10 is loaded by the torsion spring 7, release of the locking lever 12 by the flap 13 allows the canister engagement lever 10 to be driven to compress the canister 2. The protrusion 10f deflects the locking lever 12 (anticlockwise in Fig. 12) as the canister engagement lever 10 passes.

[0054] As illustrated in Fig. 13, the actuation mechanism 6 further includes a locking mechanism for locking the spindle 8 after loading of the torsion spring 7. The locking mechanism comprises a catch 14 and an intermediate member 15 which are both pivotally mounted on the axle 17, adjacent the locking lever 12. Before compression of the canister 2, the intermediate member 15 is held in the position illustrated in Fig. 13 by the cross-piece 10c of the canister engagement lever 10 contacting a first contact surface 15a adjacent the axle 17. A resilient biassing element in the form of a torsion spring 16 is connected between the catch 14 and the intermediate member 15 and loaded to bias the catch 14 towards its locking position shown in Fig. 13.

[0055] The catch 14 has a notch 14a adjacent the axle 17 for engaging the arm 8c of the spindle 8 after rotation to the position illustrated in Fig. 13 where the torsion spring 7 is loaded. In this position, the loading provided by the spring 16 prevents release of the spindle 8 and thereby holds the torsion spring 7 in its loaded state. Before loading, the arm 8c of the spindle 8 is positioned above the end 14b of the catch 14 distal from the axle 17. When the spindle 8 is driven downwards by depression of the buttons 9, the arm 8c of the spindle engages the end 14b of the catch 14 and deflects the catch 14 by compressing the spring 16 to allow passage of the arm 8c of the spindle 8.

[0056] The flap 13 further includes a stud 13d protruding from the block 13b on the opposite side of the axle 18 from the locking lever engagement surface 13a. Upon inhalation at the mouthpiece 5, the flap 13 moves to the position illustrated in Fig. 13 where the stud 13d engages a second contact surface 15b of the intermediate member 15 distal from the axle 17. Prior to this point, the stud 13d does not contact the second contact surface 15b but the intermediate member 15 has been held in place by the canister engagement lever 10. Movement of the flap 13 triggers the triggering mechanism to release the canister engagement member 10 which moves downwards out of contact with the intermediate member 15. However, the stud 13d catches the contact surface 15b and so continues to hold the intermediate member 15 with the spring 16 loaded. Accordingly, the catch 14 remains in its locking position locking the spindle 8 by engagement of the arm 8c of the spindle 8 in the notch 14a of the catch 14.

[0057] Subsequently, when the level of inhalation of the mouthpiece falls below a predetermined threshold, the flap moves out of contact with the intermediate member 15 (clockwise in Fig. 13). The level of the predetermined threshold at which the flap 13 releases the intermediate member 15 is controlled by the shape of the second contact surface 15b of the intermediate member

15.

[0058] After release by the flap 13, the intermediate member 15 is driven by spring 16 which unloads (clockwise in Fig. 13). Such unloading of the spring 16 reduces the force by which the catch 14 is biassed towards its locking position. Accordingly, the force of the torsion spring 7 acting on the canister engagement lever 10 is sufficient to force the catch arm 8c of the spindle 8 out of the notch 14a. Accordingly, the spindle 8, the torsion spring 7 and canister engagement lever 10 are able to move upwardly biassed by the reset spring acting on the canister engagement lever 10, thereby allowing the canister to reset.

[0059] The sequence of operation of the actuation mechanism 6 will now be described with reference to Figs. 14 to 22. Fig. 14A to 14F are graphs showing the angular positions of the various elements of the actuation mechanism 6. In particular, Fig. 14A illustrates the angular position of the flap 13; Fig. 14B illustrates the angular position of the locking lever 12; Fig. 14C illustrates the angular position of the canister engagement lever 10; Fig. 14D illustrates the angular position of the intermediate member 15; Fig. 14E illustrates the angular position of the catch 14; and Fig. 14F illustrates the angular position of the spindle 8. Various states and positions of the actuation mechanism 6 are labelled by the letters A to R in Figs. 14 and Figs. 15 to 22 illustrate the actuation mechanism 6 in some of these states with the views from opposite sides being suffixed by the letters A and B, respectively.

[0060] The sequence commences in state A as shown in Figs. 15 in which the torsion spring 7 has been loaded by depression of the buttons 9 and the spindle 8 is locked by the catch 14. In state A, the canister engagement lever is 10 held by the locking lever 12. The inhaler may be stored with the actuation mechanism 6 in state A.

[0061] At position B, the user starts to inhale. The flap 13, being responsive to such inhalation, starts to move. The shape of the contact surface 12b allows the locking lever 12 to start moving slowly. The actuation mechanism 6 is now in state C illustrated in Figs. 16.

[0062] At position D, the locking lever engagement surface 13a of the flap 13 releases the contact surface 12b of the locking lever 12. Accordingly, the canister engagement member 10 under the loading of the torsion spring 7 starts to rotate downwards deflecting the locking lever 12 against its reset spring as the projection 10f moves out of the notch 12a. The actuation mechanism is now in state E illustrated in Figs. 17.

[0063] At position F, the canister engagement lever 10 moves out of contact with the first contact surface 15a at the intermediate member 15 which therefore starts to move under the biassing of spring 16. However, the intermediate member 15 only moves a short way because at position G it is caught by the flap 13, in particular by the bar 13d of the flap 13 contacting the second contact surface 15b. This contact stops the movement of the flap 13 and the intermediate member 15.

[0064] The movement of the canister engagement lever 10 compresses the body 3 of the canister 2 relative to the stem 4 held in the nozzle block 11, thereby causing the canister 2 to deliver a dose of medicament. The nozzle block 11 directs the dose of medicament out of the mouthpiece at which the user is inhaling. The actuation mechanism 6 is now in state H illustrated in Figs. 18.

[0065] When the level of inhalation starts to fall, at position I the flap 13 under the biassing of its reset spring starts to move back closing the duct. This movement of the flap 13 causes the intermediate member 15 to move slightly due to the shape of the second contact surface 15b.

[0066] When the level of inhalation falls below the predetermined threshold, at position J the bar 13d of the flap 13 moves out of contact with the second contact surface 15b. This releases the intermediate member 15. Under the action of the spring 16, the intermediate member 15 moves to unload the spring 16. The actuation mechanism 6 is now in state K illustrated in Figs. 19.

[0067] At position L the load on the catch 14 from the spring 16 reduces to the extent that the catch 15 can no longer hold the spindle 8. The force of the torsion spring 7 forces the arm 8c of the spindle 8 upwards and out of engagement with the notch 14a of the catch 14. This forces the catch 14 backwards. The actuation mechanism 6 is now in state M illustrated in Figs. 20.

[0068] At position N, the torsion spring 7 reaches its neutral, unloaded position, so there is no load between the canister engagement lever 10 and the spindle 8. Thereafter the canister engagement lever 10 and the torsion spring 8 are moved under the action of the reset spring biassing the canister engagement lever 10.

[0069] At position O, the canister engagement lever 10 contacts the first contact surface 15a of the intermediate member 15 and forces it backwards. The actuation mechanism is now in state P illustrated in Figs. 21. This loads the spring 16 and pushes the catch 14 towards its locking position until the catch 14 contacts the arm 8c of the spindle 8 which has now passed out of the notch 14a.

[0070] At position Q, the projection 10f of the canister engagement lever 10 moves into the notch 12a of the locking lever 12 which snaps back into its locking position under the action of its reset spring. The actuation mechanism 6 is now in state R in Figs. 22. In state R, the canister is reset and ready to be compressed again for delivery of the next dose, but the actuation mechanism 6 is relaxed with the torsion spring 7 unloaded. The rotation of the spindle 8 has forced the buttons 9 outwards to the position illustrated in Figs. 22. The actuation mechanism 6 is ready to be loaded once again by compression of the buttons 9. The user is instructed to do this immediately after inhalation, so that the canister may be stored in a state ready to be used simply by inhaling at the mouthpiece 5.

[0071] When the user depresses the buttons 9 at position S, this drives the spindle 8 downwards. The arm 8c of the spindle 8 deflects the catch 14 slightly against the loaded spring 16 until the arm 8c moves into the notch 14a. This allows the spring 16 to snap the catch 14 into its locking position.

Claims

1. An inhaler for delivery by inhalation of a medicament from a canister (2) which is compressible to deliver a dose of medicament, the inhaler comprising

   a housing (1) for holding a canister (2) having a generally cylindrical body with the cylindrical axis of the body in predetermined direction;

   a loading mechanism for loading a resilient loading element (7) which is arranged, when loaded, to bias compression of the canister (2), characterised in that the loading mechanism comprising:

   a loading member (8) engaging the resilient loading element (7); and
   at least one contact member (9) movable relative to the housing in a movement direction orthogonal to said predetermined direction and arranged to drive the loading member (8) to load the resilient loading element (7) through a cam arrangement (8a) between the at least one contact member (9) and the loading member (8).

2. An inhaler according to claim 1, having two contact members (9) disposed on opposite sides of the housing.

3. An inhaler according to claim 1 or 2, wherein the cam arrangement includes at least one cam surface (8a) provided on the loading member (8) and engaged by the at least one contact member (9).

4. An inhaler according to any one of the preceding claims, wherein the loading member (8) is driven to move in a direction orthogonal to said movement direction.

5. An inhaler according to claim 4, wherein the loading member (8) is driven to rotate in said direction orthogonal to said movement direction.

6. An inhaler according to claim 5, wherein the resilient loading element is a torsion spring (7).

7. An inhaler according to claim 6, wherein the coils of the torsion spring (7) encircle the loading member (8).

8. An inhaler according to any one of the preceding claims, wherein the resilient loading element (7) biases a canister engagement member (10) engageable with a canister (2) held in the housing (1) to compress the canister (2).

9. An inhaler according to any one of the preceding claims, wherein the canister engagement member is a lever (10) rotatable about an axis parallel to the movement direction of the at least one contact member (9).

10. An inhaler according to any one of the preceding claims, wherein the cam arrangement is arranged to hold the at least one contact member (9) in place at the end of its movement.

11. An inhaler according to any one of the preceding claims, wherein the ratio of the amount of driven movement of the loading member (8) to the amount of movement of the at least one contact member (9) being a non-linear function of the position of the loading member (8).

12. An inhaler according to claim 11, wherein said ratio reduces during at least a major portion of the driven movement of the loading member (8).

13. An inhaler according to claim 12, wherein said ratio is inversely proportional to the position of the loading member (8) during said major portion of its driven movement.

14. An inhaler according to claim 12 or 13, wherein said ratio varies with the position of the loading member (8) during said major portion of the driven movement of the loading member (8) such that the necessary force applied to the at least one contact member (9) is substantially constant.

15. An inhaler according to any one of claims 11 to 14, wherein said ratio is reduced during an initial portion of the driven movement of the loading member (8) relative to the subsequent portion.

16. An inhaler according to any one of claims 11 to 15, wherein the at least one contact member (9) drives the loading member (8) through a non-linear cam arrangement.

17. An inhaler according to claim 16, wherein the cam arrangement is arranged to hold the at least one contact member (9) in place at the end of its movement.

18. An inhaler according to any one of the preceding claims, further comprising a triggering mechanism arranged to hold the resilient loading element (7)

against actuation of the canister (2) and triggerable to release the resilient loading element (7).

19. An inhaler according to claim 18, wherein the triggering mechanism is arranged to be triggered by inhalation.

Patentansprüche

1. Inhalator zur Abgabe eines Medikaments durch Inhalation aus einem Behältnis (2), das zur Abgabe einer Medikamentendosis zusammengedrückt werden kann, wobei der Inhalator Folgendes umfasst:

    ein Gehäuse (1) zum Halten eines Behältnisses (2) mit einem allgemein zylindrischen Körper, wobei die zylindrische Achse des Körpers in einer vorbestimmten Richtung verläuft,
    einen Belastungsmechanismus zum Belasten eines federnden Belastungselements (7), das im belasteten Zustand so angeordnet ist, dass es das Zusammendrücken des Behältnisses (2) vorspannt, dadurch gekennzeichnet, dass der Belastungsmechanismus Folgendes umfasst:

        ein Belastungsglied (8), das das federnde Belastungselement (7) in Eingriff nimmt, und
        mindestens ein Kontaktglied (9), das bezüglich des Gehäuses in einer Bewegungsrichtung bewegt werden kann, die orthogonal zu der vorbestimmten Richtung verläuft, und zum Antrieb des Belastungsglieds (8) angeordnet ist, um das federnde Belastungselement (7) durch eine Nockenanordnung (8a) zwischen dem mindestens einen Kontaktglied (9) und dem Belastungsglied (8) zu belasten.

2. Inhalator nach Anspruch 1 mit zwei Kontaktgliedern (9), die auf gegenüberliegenden Seiten des Gehäuses angeordnet sind.

3. Inhalator nach Anspruch 1 oder 2, bei dem die Nockenanordnung mindestens eine Nockenfläche (8a) aufweist, die am Belastungsglied (8) vorgesehen ist und von dem mindestens einen Kontaktglied (9) in Eingriff genommen wird.

4. Inhalator nach einem der vorhergehenden Ansprüche, bei dem das Belastungsglied (8) so angetrieben ist, dass es sich in einer orthogonal zu der Bewegungsrichtung verlaufenden Richtung bewegt.

5. Inhalator nach Anspruch 4, bei dem das Belastungsglied (8) so angetrieben ist, dass es sich in der orthogonal zu der Bewegungsrichtung verlaufenden Richtung dreht.

6. Inhalator nach Anspruch 5, bei dem es sich bei dem federnden Belastungselement um eine Drehstabfeder (7) handelt.

7. Inhalator nach Anspruch 6, bei dem die Windungen der Drehstabfeder (7) das Belastungsglied (8) umgeben.

8. Inhalator nach einem der vorhergehenden Ansprüche, bei dem das federnde Belastungselement (7) ein Behältniseingriffsglied (10) vorspannt, das mit einem im Gehäuse (1) gehaltenen Behältnis (2) in Eingriff gebracht werden kann, um das Behältnis (2) zusammenzudrücken.

9. Inhalator nach einem der vorhergehenden Ansprüche, bei dem es sich bei dem Behältniseingriffsglied um einen Hebel (10) handelt, der um eine parallel zur Bewegungsrichtung des mindestens einen Kontaktglieds (9) verlaufende Achse gedreht werden kann.

10. Inhalator nach einem der vorhergehenden Ansprüche, bei dem die Nockenanordnung so angeordnet ist, dass sie das mindestens eine Kontaktglied (9) am Ende seiner Bewegung festhält.

11. Inhalator nach einem der vorhergehenden Ansprüche, bei dem das Verhältnis des Betrags angetriebener Bewegung des Belastungsglieds (8) zu dem Betrag der Bewegung des mindestens einen Kontaktglieds (9) eine nicht lineare Funktion der Position des Belastungsglieds (8) ist.

12. Inhalator nach Anspruch 11, bei dem sich das Verhältnis während mindestens eines Großteils der angetriebenen Bewegung des Belastungsglieds (8) verringert.

13. Inhalator nach Anspruch 12, bei dem das Verhältnis umgekehrt proportional zu der Position des Belastungsglieds (8) während des Großteils seiner angetriebenen Bewegung ist.

14. Inhalator nach Anspruch 12 oder 13, bei dem das Verhältnis mit der Position des Belastungsglieds (8) während des Großteils der angetriebenen Bewegung des Belastungsglieds (8) so variiert, dass die auf das mindestens eine Kontaktglied (9) ausgeübte notwendige Kraft im Wesentlichen konstant ist.

15. Inhalator nach einem der Ansprüche 11 bis 14, bei dem das Verhältnis während eines anfänglichen Teils der angetriebenen Bewegung des Belastungsglieds (8) bezüglich des nachfolgenden Teils verrin-

gert ist.

16. Inhalator nach einem der Ansprüche 11 bis 15, bei dem das mindestens eine Kontaktglied (9) das Belastungsglied (8) durch eine nicht lineare Nockenanordnung antreibt.

17. Inhalator nach Anspruch 16, bei dem die Nockenanordnung so angeordnet ist, dass sie das mindestens eine Kontaktglied (9) am Ende seiner Bewegung festhält.

18. Inhalator nach einem der vorhergehenden Ansprüche, weiter mit einem Auslösemechanismus, der so angeordnet ist, dass er das federnde Belastungselement (7) gegen eine Betätigung des Behältnisses hält, und zur Freigabe des federnden Belastungselements (7) ausgelöst werden kann.

19. Inhalator nach Anspruch 18, bei dem der Auslösemechanismus so angeordnet ist, dass er durch Inhalation ausgelöst wird.

Revendications

1. Inhalateur pour délivrer par inhalation un médicament à partir d'un réservoir (2) pouvant être comprimé pour délivrer une dose de médicament, l'inhalateur comprenant :

    un boîtier (1) pour supporter un réservoir (2) présentant un corps essentiellement cylindrique, l'axe cylindrique du corps étant orienté dans une direction prédéterminée ;
    un mécanisme de chargement pour charger un élément de mise en charge élastique (7) arrangé, une fois chargé, pour exécuter la compression du réservoir (2), caractérisé en ce que le mécanisme de chargement comprend :

        un élément de chargement (8) engageant l'élément de mise en charge élastique (7) ; et
        au moins un élément de contact (9) mobile par rapport au boîtier dans une direction de déplacement orthogonale à ladite direction prédéterminée et arrangé de manière à entraîner l'élément de chargement (8) à charger l'élément de mise en charge élastique (7) par l'intermédiaire d'un arrangement de came (8a) entre le au moins un élément de contact (9) et l'élément de chargement (8).

2. Inhalateur selon la revendication 1, comprenant deux éléments de contact (9) disposés sur des côtés opposés du boîtier.

3. Inhalateur selon la revendication 1 ou 2, dans lequel l'arrangement de came comprend au moins une surface de came (8a) prévue sur l'élément de chargement (8) et engagée par le au moins un élément de contact (9).

4. Inhalateur selon l'une quelconque des revendications précédentes, dans lequel l'élément de chargement (8) est entraîné à se déplacer dans une direction orthogonale à ladite direction de déplacement.

5. Inhalateur selon la revendication 4, dans lequel l'élément de chargement (8) est entraîné à tourner dans ladite direction orthogonale à ladite direction de déplacement.

6. Inhalateur selon la revendication 5, dans lequel l'élément de mise en charge élastique est un ressort de torsion (7).

7. Inhalateur selon la revendication 6, dans lequel les spires du ressort de torsion (7) encerclent l'élément de chargement (8).

8. Inhalateur selon l'une quelconque des revendications précédentes, dans lequel l'élément de mise en charge élastique (7) pousse un élément d'engagement de réservoir (10) pouvant être engagé avec un réservoir (2) supporté dans le boîtier (1) afin de comprimer le réservoir (2).

9. Inhalateur selon l'une quelconque des revendications précédentes, dans lequel l'élément d'engagement de réservoir est un levier (10) pouvant tourner autour d'un axe parallèle à la direction de déplacement du au moins un élément de contact (9).

10. Inhalateur selon l'une quelconque des revendications précédentes, dans lequel l'arrangement de came est arrangé de manière à maintenir en place le au moins un élément de contact (9) à la fin de son déplacement.

11. Inhalateur selon l'une quelconque des revendications précédentes, dans lequel le rapport de l'ampleur du déplacement entraîné de l'élément de chargement (8) et de l'ampleur du déplacement du au moins un élément de contact (9) est une fonction non linéaire de la position de l'élément de chargement (8).

12. Inhalateur selon la revendication 11, dans lequel ledit rapport diminue pendant au moins une majeure partie du déplacement entraîné de l'élément de chargement (8).

13. Inhalateur selon la revendication 12, dans lequel le-

dit rapport est inversement proportionnel à la position de l'élément de chargement (8) pendant ladite partie majeure de son déplacement entraîné.

14. Inhalateur selon la revendication 12 ou 13, dans lequel ledit rapport varie avec la position de l'élément de chargement (8) pendant ladite partie majeure du déplacement entraîné de l'élément de chargement (8), de telle sorte que la force nécessaire appliquée audit au moins un élément de contact (9) soit essentiellement constante.

15. Inhalateur selon l'une quelconque des revendications 11 à 14, dans lequel ledit rapport diminue pendant une partie initiale du déplacement commandé de l'élément de chargement (8) par rapport à la partie suivante.

16. Inhalateur selon l'une quelconque des revendications 11 à 15, dans lequel le au moins un élément de contact (9) entraîne l'élément de chargement (8) par l'intermédiaire d'un arrangement de came non linéaire.

17. Inhalateur selon la revendication 16, dans lequel l'arrangement de came est arrangé de manière à maintenir en place le au moins un élément de contact (9) à la fin de son déplacement.

18. Inhalateur selon l'une quelconque des revendications précédentes, comprenant en outre un mécanisme de déclenchement arrangé de manière à maintenir l'élément de mise en charge élastique (7) contre l'actionnement du réservoir (2), et pouvant être actionné pour relâcher l'élément de mise en charge élastique (7).

19. Inhalateur selon la revendication 18, dans lequel le mécanisme de déclenchement est arrangé de manière à être déclenché par inhalation.

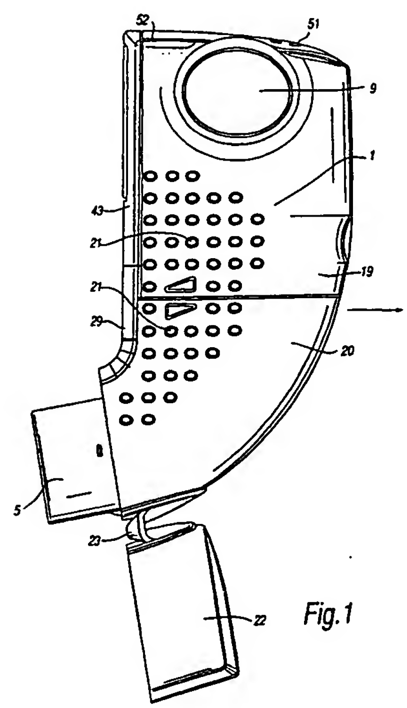

Fig.1

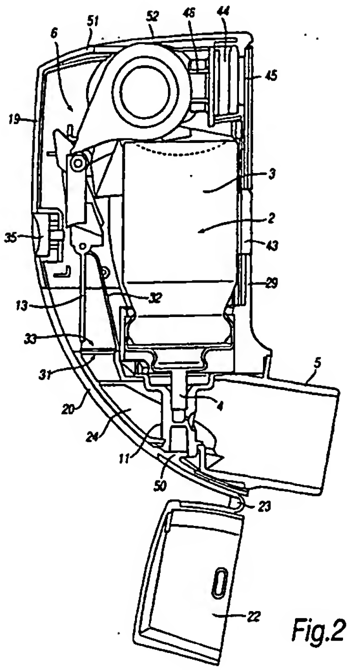

Fig.2

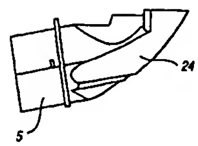

Fig.3

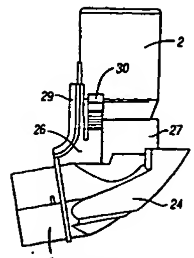

Fig.4

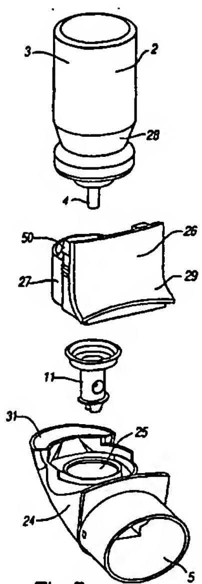

Fig.5

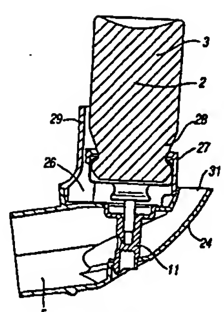

Fig.6

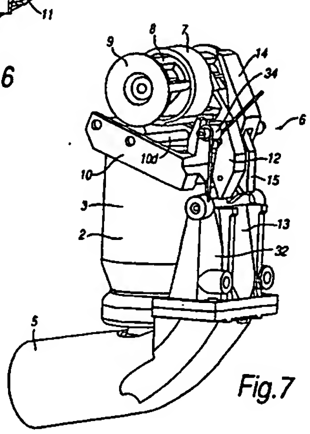

Fig.7

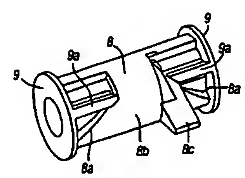

Fig.8

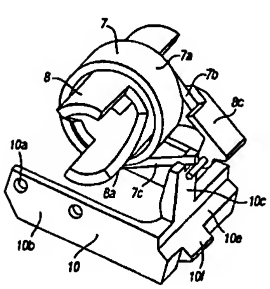

Fig.9

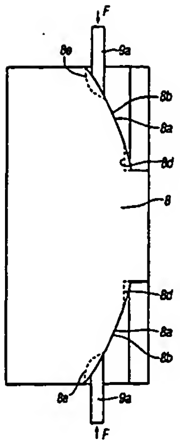

Fig.10

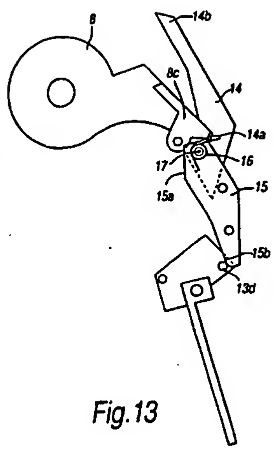

Fig.13

EP 1 267 974 B1

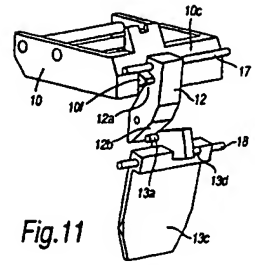

Fig.11

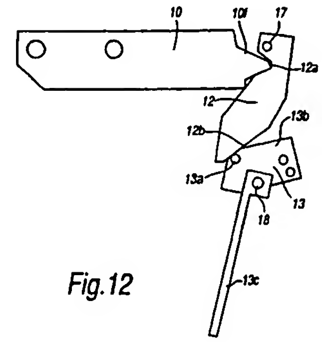

Fig.12

EP 1 267 974 B1

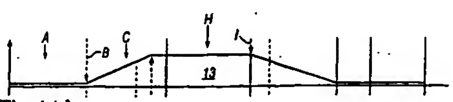

Fig.14A

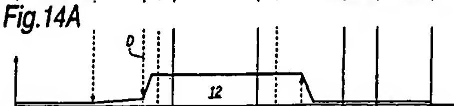

Fig.14B

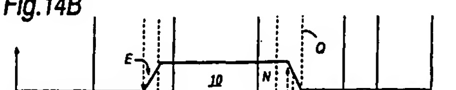

Fig.14C

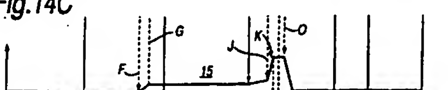

Fig.14D

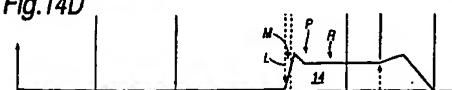

Fig.14E

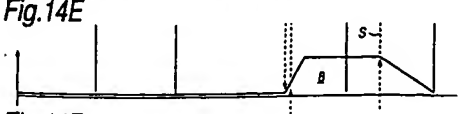

Fig.14F

EP 1 267 974 B1

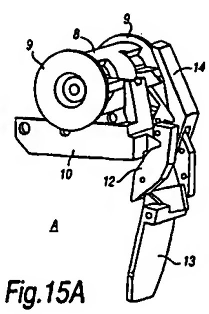

Fig.15A

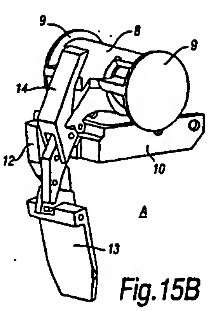

Fig.15B

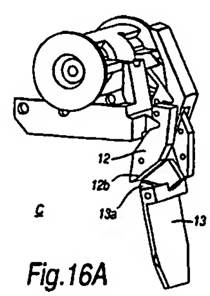

Fig.16A

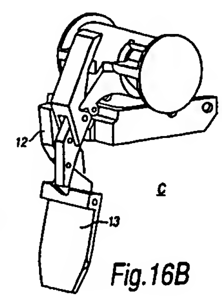

Fig.16B

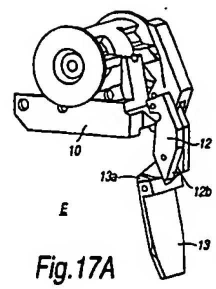

Fig.17A

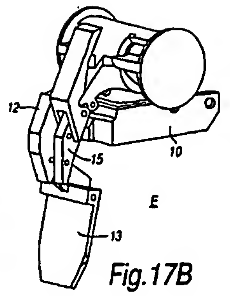

Fig.17B

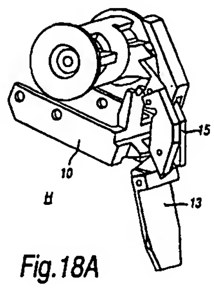

Fig.18A

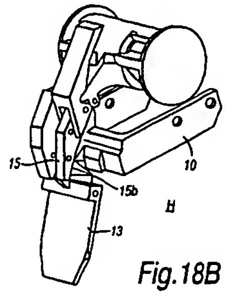

Fig.18B

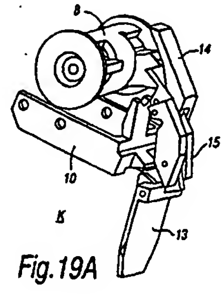

Fig.19A

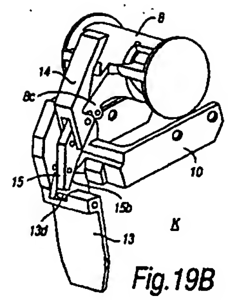

Fig.19B

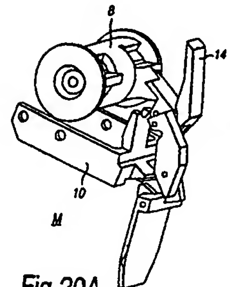

Fig.20A

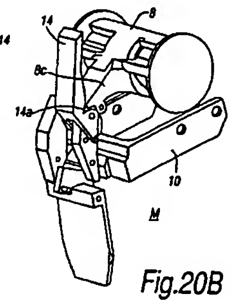

Fig.20B

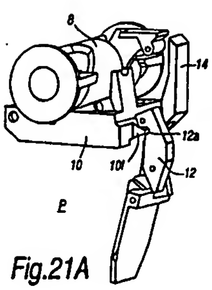

Fig.21A

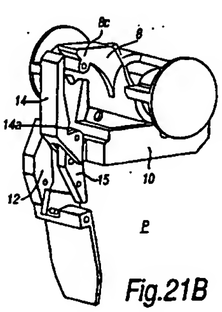

Fig.21B

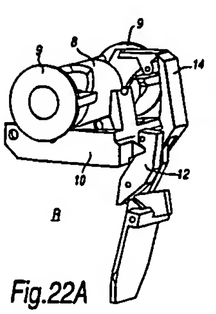

Fig.22A

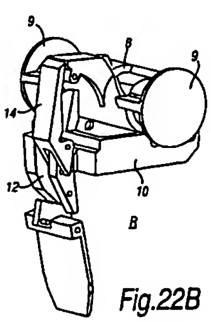

Fig.22B